USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: Macropore Flow: A Means for Enhancing Groundwater Recharge or a Potential Source of Groundwater Contamination

Focus Categories: GW, WQL

Keywords: Groundwater, Models, Runoff, Urbanization

Duration: March 1, 1999 - February 28, 2000

FY 1999 Federal Funds: $19,750

FY 1999 Non-federal Funds: $24,819

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Congressional District: Second Wisconsin

Statement of Critical Regional or State Water Problems

As urban areas expand, groundwater levels and heads decrease as a result of the combined effects of groundwater pumping and loss of groundwater recharge. In some cases these decreases constrain the use of groundwater. More commonly, they result in reduced flows to springs, streams, lakes and wetlands. Diffuse infiltration of stormwater has been proposed as a potential management strategy for mitigating groundwater depletion due to urban expansion. The idea is to carefully manage storm runoff from impervious surfaces so that as much runoff as possible sheetflows over adjacent pervious surfaces that are managed to maximize infiltration capacity. Innovative consulting firms such as Conservation Design Forum in Naperville, IL are beginning to apply such an approach to development projects in the upper Midwest, including the expansion of the University Research Park in Madison, WI.

Successful implementation of diffuse stormwater infiltration requires identification of sites with high permeabilities. The matrix permeability of soils in the upper Midwest are generally low to moderate; however, if macropores are present, the effective permeabilities can be much higher. Hence, macropores may be critical to the effectiveness of diffuse infiltration. Exploiting macropore flow has a potential drawback - urban stormwater can be highly contaminated and macropore plow could become a source of groundwater contamination.

Statement of Results or Benefits

This proposed research will provide useful information about the potential benefits and risks associated with diffuse infiltration of stormwater runoff from impervious surfaces.

Diffuse infiltration may offer an efficient and effective way to mitigate the reduction in groundwater levels and heads associated with urban development. At the same time, infiltration of contaminated stormwater could cause groundwater contamination. Macropore flow, which has been shown to be an important process in agricultural settings, would greatly enhance the potential of diffuse infirltration, but would also increase the risk of groundwater contamination. This research will provide useful information about the significance of macropore flow in urban greenspaces in Dane County, Wisconsin. The resulting information would be transferable to much of the upper Midwest.

Nature, Scope and Objectives of the Research

he proposed research has two principal components -- infiltration testing of soils in urban/suburban greenspaces in Dane County, and modeling of diffuse infiltration of stormwater runoff. The objective of the infiltration testing is to investigate the importance of macropore flow in urban greenspaces as both a mechanism for increasing groundwater recharge as well as a source of groundwater contamination. The objective of the modeling component is to quantify the potential groundwater recharge rates achievable by coupling an impervious surface to a pervious one.

Two field methods will be used to investigate macropore flow in urban greenspaces in Dane County. We will use a large-diameter double-ring infiltrometer to determine whether macropore flow is occurring in a given location. Steady-state infiltration rates that greatly exceed those normally associated with the given soil type will be considered as an indicator of macropore flow. At these sites we will use a disc permeameter/tension infiltrometer to study infiltration in more detail and to quantify infiltration parameters for subsequent use in modeling. We will focus our field investigations on large greenspaces that are near to, and down-slope from, large impervious services, such as roofs, parking lots, and paved outdoor work areas. The former present potential opportunities for diffuse infiltration; the latter are potential sources of groundwater contamination.

The objective of the modeling is to quantify the potential groundwater recharge rates achievable by diffuse infiltration of stormwater runoff from impervious surfaces. We will model both hypothetical conditions as well as cases selected from our field studies. Modeling will be based on a public domain version of CASDC2D (Julien et al., 1995), a two-dimensional, physically-based rainfall-runoff model that simulates infiltration of runoff from adjacent upslope areas.